

**Testimony of Dr. Willie E. May  
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**Before The Senate Committee on Commerce, Science, and  
Transportation Subcommittee on Science, Technology and Space in a Hearing on  
"E-Health and Technology: Empowering Consumers in a Simpler, More Cost Effective  
Health Care System"  
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Mr. Chairman and Members of the Subcommittee, thank you for the invitation to testify today. My name is Willie E. May. I am Chief of the Analytical Chemistry Division, Chemical Science and Technology Laboratory, National Institute of Standards and Technology (NIST). I am pleased to be offered the opportunity to add to this discussion regarding ways and means for increasing the effectiveness of our health care system. I will focus on the role that national measurement standards can play in increasing the accuracy and reliability of health care measurements that should lead to better medical decision-making and more efficient use of available health care resources.

**Overview:**

Chemical and physical measurements provide information that is extremely important for the prevention, diagnosis, and treatment of disease. Clinical measurement results used by medical and other health care decision makers that are reliable and comparable over both space and time are essential for optimal patient care, most efficient use of available health care funds, and full utilization of the potential of new information technology tools. The accuracy and traceability of the data from medical tests are becoming increasingly important. Typically, medical guidelines are derived from clinical studies where medical outcomes are correlated with medical test results. Such data are often collected using many different laboratories and instruments, in different parts of the world, and at different times. However, effective use of such data will require that any differences observed be attributable to the clinical parameter(s) being measured and not to the measurement processes. Valid decision-making requires that a medical test result for an individual patient – from a different laboratory at a later time – be correlated to the clinical study data for the broader population. This can be only accomplished if all measurement results are of known quality. NIST can contribute to increased efficiency in health care delivery by providing the measurement quality assurance tools – reference measurement methods, certified reference materials and calibrations – needed to improve measurement accuracy and reliability.

**Measurement Reliability and Cost Issues:**

A 1999 study by the National Academy of Sciences Institute of Medicine discussed the impact of medical errors on health care costs within the United States. While the majority of medical errors are not due to inaccurate measurements, improved measurement accuracy could save lives, a significant amount of time and money, and improve our quality of life. Health care costs are estimated to exceed \$1.3T in 2001 and currently represent over 14 % of the U.S. GDP. Estimates of the portion of these

costs that are measurement related vary by which activities are included, but typically range from 10% - 15%. The *Washington Post* and *Medical Laboratory Observer* have reported that 25% - 30% of health-related measurements are performed for non-diagnostic reasons (re-test, error prevention and detection). While not providing an explicit number for the cost of non-diagnostic measurements, the Committee on Quality of Health Care in America, in a 1999 Report, "To Err Is Human: Building a Safer Health System ([http://books.nap.edu/html/to\\_err\\_is\\_human/exec\\_summ.html](http://books.nap.edu/html/to_err_is_human/exec_summ.html)), stated that "Dollars spent on having to repeat diagnostic tests ... are dollars not available for other purposes. Purchasers and patients pay for errors when insurance costs and copayments are inflated by services that would not have been necessary had proper care been provided. It is impossible for the nation to achieve the greatest value possible from the billions of dollars spent on medical care if the care contains errors." The "German Health Report of 1998" ([www.gbe-bund.de](http://www.gbe-bund.de)) states explicitly that "the costs of repeat measurement amounts to \$1.5 B U.S. per year in Germany." If normalized to the U.S. GDP for that year, these costs would be \$7.4 B. Even modest improvements in measurement accuracy and quality assurance will result in multi-billion dollar savings in health care costs.

Considerable data exist to demonstrate the effectiveness of NIST's measurement, standards and calibration activities in the areas of clinical chemistry, radiation therapy, and medical imaging. The accuracy of all 26 million mammograms and 600,000 cancer patients treated with radiation (per year) trace to physical measurement standards at NIST. A flat panel display metrology standard has been developed in our Electronics and Electrical Engineering Laboratory that has allowed the Mayo Clinic, Scottsdale AZ, to upgrade its diagnostic capabilities by moving from traditional x-ray photo images viewed on light panels to video flat panel displays. Converting from radiographs to digital images viewed on flat panel displays eliminated the need for an estimated one million radiographs per year (estimated at about \$1.50 per radiograph.). The NIST Advanced Technology Program (ATP) has awarded several grants to companies seeking to improve the flow of information between health care providers. For example, VitalWorks of Waltham, MA, used ATP support to adapt an existing computer note-writing system so that it could capture clinical data automatically through a pleasing user interface. This new technology makes it easy and productive for physicians to enter patient data directly into computers, an advance that overcomes a major obstacle to the conversion from paper to electronic medical records. NIST also develops and disseminates organizational performance metrics for health care through its Baldrige National Quality Program.

As you can see, NIST has many activities that contribute to improving the effectiveness of health care delivery; however, I'll talk in detail only about the area that I'm most familiar with – measurement methods and standards for clinical diagnostic markers. For more than 20 years, NIST has developed, maintained and refined "Definitive Methods" for health status markers to support the national reference system for clinical measurements, including but not limited to calcium, chloride, cholesterol, creatinine, glucose, lithium, magnesium, potassium, sodium, triglycerides, urea, and uric acid. NIST methods for these health status indicators have been used to value-assign Standard Reference Materials that NIST sells to the public and reference serum pools used by the Centers for Disease Control and Prevention (CDC) as the anchor point for its reference methods and by the College American Pathologists (CAP) as its benchmark for proficiency testing more than 15,000 U.S. clinical laboratories. Improved accuracy facilitated by this program has led to better diagnosis, treatment and reduced health care costs.

The provision of these accuracy-based anchor points for the clinical measurement community also facilitates the development and critical evaluation of new measurement technologies for providing cheaper and faster test results.

**Results of Measurements of Troponin from Same Sample Pool Using Immunoassay Kits from Three Different Manufacturers**

<b>Assay Manufacturer</b>	<b>Troponin-I Concentration ng/mL</b>	<b># labs reporting</b>
<b>A</b>	<b>19.9</b>	<b>115</b>
<b>B</b>	<b>6.7</b>	<b>489</b>
<b>C</b>	<b>0.85</b>	<b>7</b>

*From G. S. Bodor, Denver Health and Hospitals  
personal communication 1997*

A new generation of health status markers, now emerging, shows great promise from the clinical diagnostic perspective, but offers new and more difficult challenges for measurements and standardization. Many of the new markers are proteins, peptides, or other large biomolecules, usually present at very low concentrations. Because of the vast market for tests for these new markers, many different approaches have been developed that often provide different answers. For example, Cardiac Troponin-I is a protein that is found in heart muscle that is released into the blood following acute myocardial infarction (AMI). In controlled studies, it has been shown to be a highly specific diagnostic marker for heart attack. Currently, data from tests for Cardiac Troponin-I can be used only in a very restricted manner. Medical decision points are manufacturer-specific, and therefore, decisions cannot be made based on norms established from broad population groups. While the range of results reported in the Table provided here are a bit extreme, this lack of comparability exists for many other very important clinical diagnostic markers, whose utility are therefore not being fully realized. This lack of comparability among Cardiac Troponin-I assays is very significant since heart disease is the number one cause of death in the United States -- accounting for 1/3 of all deaths. Acute myocardial infarction is responsible for 30% of these deaths. Approximately 6 million people visit Emergency Rooms (ERs) annually for chest pain and approximately 3 million of these are admitted for possible AMI. Of these, 2 million are not diagnosed as having AMI [false positive result that potentially lead to unnecessary medical costs]. Of those not admitted, 2% - 8 % actually had an AMI [false negative result that might cause delayed treatment which could result in severe medical consequences].

Recently, Dr. George G. Klee of the Mayo Clinic in Rochester, MN, has shared information with us regarding the effect of measurement bias on medical decision-making. He used the frequency distributions of cholesterol values from 20,000 patients to mathematically model the wide variations in medical diagnoses that small measurement biases/errors can produce. As an example, in this group, 249 patients per 1000, had cholesterol levels higher than 240 mg/dL -- the level at which current guidelines call for further testing and the possible need for medication. A +3% error in the test would result in an additional 51 persons per 1000, being incorrectly reported to need this medical intervention. In this false positive case, patients could either get retested or be subjected to the prescribed medical intervention, both entailing unnecessary costs. His work showed that if conversely, there were a -3%

bias, 46 people would be missed and thereby have treatment delayed or omitted altogether, both potentially leading to dire consequences.

In 1969, the variability of cholesterol in blood measurements was reported to be ~18% in College of American Pathologists Proficiency Testing Surveys. Over the next 25 years, NIST (definitive measurement methods and Standard Reference Materials) in cooperation with the CAP (proficiency testing) and the CDC (reference methods and reference laboratory network) established and maintains a reference system for cholesterol measurements that has contributed to a steady decrease in the measurement variability to the ~5% level in 1994 [Cholesterol Measurement Test Accuracy and Factors that Influence Cholesterol Levels, General Accounting Office Report GAO/PEMD-95-8, December 1994]. These improvements represent potential savings of over \$100M per year in treatment costs for misdiagnosed patients, in addition to the lives saved through timely and accurate diagnosis.

Driven by the availability of new sensor-based measurement technologies, more and more clinical testing is being done outside the traditional clinical laboratory. The annual U.S. market alone for this new form of clinical measurements, called point-of-care testing (POCT), is currently estimated at a billion dollars and is estimated to be growing at an annual rate of 10%. POCT is expected to be used extensively in the home as a part of a self-care trend, which is also experiencing rapid growth. Some studies have indicated that POCT can provide nearly the same level of diagnostic value as centralized testing, but at half the cost. Therefore the standards infrastructure that has supported clinical chemistry for the past three decades must adapt to support POCT. New techniques and non-biohazard standards based on biomimetic materials are needed to assure the accuracy of POCT. NIST leadership in developing accurate and internationally-recognized and accepted POCT standards will help assure continued U.S. dominance of the worldwide *in vitro* diagnostics (IVD) market and foster better and more affordable health care both at home and abroad.

#### **New Measurement and Standards-Related Commerce and Competitiveness Issues:**

In addition to the reliability and related cost issues that we have discussed up to now, another important measurement-related driver has recently emerged. On December 7, 1998, the European Directive 98/79/EC on *in vitro* diagnostic medical devices was published in the Official Journal of the European Communities, marking the start of a transition period of five years. An *in vitro* diagnostic device is any medical device intended for use in the testing of samples derived from the human body. The stated purposes of the directive are to eliminate trade barriers within Europe by ensuring access to the entire European Union (EU) market with one single product approval (CE marking), and at the same time to maintain or improve the level of health protection attained in the EU Member States. By December 2003 all new IVD products that are placed on the EU market must be labeled with the CE mark. In order to apply the CE mark, the manufacturer must declare that his product complies with all the "essential requirements" of the Directive. One of the major components of this directive is a requirement that products be traceable to "standards of the highest order", e.g., nationally/internationally recognized certified reference materials (CRMs). At present, neither CRMs nor reference methods are available for most of the several hundred analytes that are measured in medical laboratories. Excluding home

diagnostics, the overall world wide *in-vitro* diagnostic market is approximately \$20 billion. The total IVD market in Europe was about \$5.6 billion in 1998. Approximately 60% of the IVD products on the European market are imported from the USA.

In November 2000, NIST convened a Workshop on "Measurement Traceability for Clinical Laboratory and *in Vitro* Diagnostic Testing Systems". There were over 150 participants in attendance, with representatives from the IVD industry, regulatory agencies, international standards laboratories, commercial providers of clinical reference materials and proficiency testing services, and professionals involved in standardization of laboratory methods. The consensus of the group was for the establishment of global reference systems composed of reference laboratories, reference methods, reference materials (issued by National Measurements and Standards Institutes), and a mechanism for demonstrating measurement equivalence among national standards. The participants agreed that internationally recognized measurement and standards laboratories should be the initial nodes in this reference network, and that this system should expand rapidly to include nodes distributed around the world. There was concurrence that when properly implemented, measurement traceability -- to national and/or internationally recognized standards -- is a value-added component that will improve patient care, testing accuracy, reliability and availability, market access, and, in the long run, reduce costs. They all agreed that NIST should continue to provide leadership in the establishment of this reference system.

### **Why NIST Should be Involved:**

As stated earlier, NIST has many activities that contribute to improving the effectiveness of health care delivery and has a long history of excellence in the development of unbiased and authoritative measurement methods, reference materials, calibrations, and evaluated databases. These, coupled with new innovative preventive, diagnostic and treatment technologies, can play a key role in enhancing the quality of life in the U.S. and throughout the world. According to the Advanced Medical Technology Association (formerly, Health Industry Manufacturers Association), "the lack of organized measurement-related research can be best addressed by the coordinated efforts of NIST working together with industry". Standards-related research and measurement services, and the development and transfer of new measurement technologies are part of NIST's congressionally mandated mission and can help to facilitate the reduction of the overall cost of health care in the U.S. Close working relationships are already established with industry, the public sector and international organizations concerned with public health to assure that new measurement and technology needs are understood and properly addressed.

There are a number of technical, regulatory, and economic needs for traceability to national measurement standards: instrumentation used in the area of health care diagnostics and therapy requires accurate calibration; regulatory agencies such as the FDA and NRC require NIST traceability for medical devices and radiation therapy instrumentation; one-third of U.S. hospital patients' treatment involves radiopharmaceuticals with dosages traceable to NIST; and proliferation of foreign requirements

for quality systems documentation (such as European Directive 98/79/EC on *in vitro* diagnostic medical devices) will greatly expand the need for NIST traceability for export of U.S. health care technology. The NIST role in health care is complementary to the role of the National Institutes of Health (NIH). NIH relies on NIST and CDC to facilitate clinical measurement accuracy and on the College of American Pathologists for proficiency testing of hospital and clinical laboratories in the U.S. For 15 years, the CAP maintained a Reference Laboratory at NIST for the development of advanced clinical methods and reference materials.

**Summary:**

I was asked to focus my testimony on the measurement standards needed to improve efficiency in health care delivery and to comment on the role of reliable data in e-health. I hope that I have provided you with useful information regarding the waste and inefficiency caused by unreliable and inconsistent health care measurement data as well as the benefits of nationally and internationally traceable measurements and standards in addressing increasing needs for measurement quality systems documentation.

In addition to NIST's chemical and physical measurement standards activities, expertise resides in our Information Technology Laboratory to work with the health care community to overcome barriers to the effective integration of information technologies into the administrative and clinical measurement sectors of the health care industry. It is estimated that as much as 20% of health care costs is associated with processing information. The implementation of standards to support electronic interchange of information could result in tremendous savings — some estimates are as high as \$9B per year.

Additional savings would result from more effective linkage of measurement results with medical decision-making. However, to fully realize the benefits that information technology can provide to health care delivery, we need health care measurements of improved quality as input data.

In closing, I have tried to demonstrate that NIST can make significant contributions to increasing the efficiency of health care delivery.

Thank you Mr. Chairman. This completes my statement and I will be happy to entertain questions.